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HARTMAN AND HARTMAN, P.C.
552 EAST 700 NORTH
VAIPARAISO, IN 46383

EXAMINER

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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 09/524,227
Filing Date: March 13, 2000
Appellant(s): SPITSBERG, IRENE T.

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GROUP 1700

Domenica N.S. Hartman
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 4/19/06 appealing from the Office action mailed 5/26/05.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

4,514,469	Loersch et al.	4-1985
4,512,817	Duhl et al.	4-1985
5,238,752	Duderstadt et al.	8/1993
6,210,744	Hayess et al.	4-2001
JP 01-180959 A	Nakamura et al.	7-1989

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1, 4 –8, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A). Regarding independent **Claim 1**, the AAPA teaches a method of making a thermal barrier coating (TBC) system by depositing a diffusion aluminide bond coat that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the step of depositing the diffusion aluminide bond coat on the component so as to be characterized by substantially columnar grains that extend substantially through the portion of the bond coat overlying the surface of the component, the grains having grain boundaries exposed at the surface of the aluminide bond coat, and depositing a ceramic layer on the surface of the aluminide bond coat to form a thermal barrier coating (See "PRIOR ART" Figures 2 – 5, page 8, lines 8 – 34, page 9, lines 1 – 35, and page 10, lines 1 – 24, of the applicant's specification, which depict and describe a TBC system of a type known in the art). The AAPA does not explicitly teach improving the thermal fatigue life of the TBC by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat.

Nakamura et al. teaches that, after depositing a diffusion coating layer of Al (i.e., an aluminide bond coat) on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is shot-peened and then

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heated to a temperature at or above the recrystallization temperature of the coating layer, thereby causing recrystallized grains (i.e., “new grains”) to form on the surface of the diffusion coating layer (Abstract). This recrystallization process advantageously allows the component / coating (1) to have an improved thermal fatigue resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract). Therefore, it would have been obvious to one of ordinary skill in the art to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component / blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance, (2) a lower crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system).

With respect to the surface instabilities, it is noted that following the depositing step, the surface of the aluminide bond coat has surface irregularities as a result of grain boundary ridges defined by the grain boundaries at the surface of the aluminide bond coat (AAPA at Figure 2, page 9, lines 1 – 35, and page 10, lines 1 – 7), and following the recrystallizing step, the new grains cause the surface of the bond coat to be smoother and flatter as a result of eliminating at least some of the grain boundary ridges, whereby the ceramic layer is deposited on the smoother and flatter surface of the aluminide bond coat. Specifically, the combination of the AAPA and

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Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the flattened grain boundary ridges and smoother bond coat surface obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having flattened grain boundary ridges and a smoother bond coat surface on which the ceramic layer is deposited.

The combination of the AAPA and Nakamura et al. also teaches all the limitations of **Claims 4 –8, 10** as set forth above in paragraph 6 and below, including a method wherein / further comprising:

- Claim 4: The new grains have a grain size of not smaller than 5 micrometers after recrystallization. Specifically, although Nakamura et al. teaches that the new grains are "small" and "fine" (Abstract), Nakamura et al. is silent as to the specific size of the recrystallized grains. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature.

Since the grain size obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced new grains having a grain size of not smaller than 5 micrometers unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 5: The new grains are substantially equiaxed. Specifically, Nakamura et al. is silent regarding the orientation of the recrystallized grains. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced substantially equiaxed grains unless essential process steps and/or limitations are missing from the applicant's claims.
- Claim 6: The aluminide bond coat is a single-phase or two-phase aluminide prior to recrystallization (page 9, lines 17 – 22, of the applicant's specification).

- Claim 7: Precipitates are present in the grain boundaries of the grains after the depositing step and before recrystallization (see, for example, page 9, lines 29 – 35 of the specification), and the precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. Specifically, the combination of the AAPA and Nakamura et al. is silent regarding precipitates at the grain boundaries after recrystallization. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having substantially no precipitates at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.
- Claim 8: The aluminide bond coat is single-phase aluminide after recrystallization. Specifically, the AAPA teaches that the bond coat, as deposited, is a single-phase or two-phase diffusion aluminide (page 9, lines 17 – 19, of the applicant's specification). Additionally, the combination of the AAPA and Nakamura et al. teaches each and

every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the single phase aluminide obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant (for support, see, for example, page 14, lines 18 – 20 of the applicant's specification, which indicates that a bond coat recrystallization process yields a single-phase), and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having a single-phase aluminide structure unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 10: The aluminide bond coat is a platinum aluminide bond coat (page 9, lines 11 – 19 of the applicant's specification).

Claims 2, 11, 13–18, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), and in further view of Loersch et al. (USPN 4,514,469).

The combination of the AAPA and Nakamura et al. teaches all the limitations of **Claim 2** as set forth above in paragraph 6, except for a method wherein the recrystallization is induced by peening the bond coat at an intensity of at least 6A prior to heating the bond coat. Specifically,

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Nakamura et al. teaches inducing the recrystallization by peening the bond coat prior to heating the bond coat (Abstract) but does not explicitly teach the claimed peening intensity. As verified by an oral translation from a USPTO translator, Nakamura et al. is silent regarding the specific peening intensity. However, it is clear that the peening intensity of Nakamura et al. must be high enough to induce plastic deformation to the diffusion coating layer (Abstract). Loersch et al. teaches that, in the art of peening bond coatings on metal workpieces such as turbine airfoils, the peening intensity must be high enough to achieve a good surface finish (e.g., closure of surface defects) in an economical period of time, but not so high as to chip or physically degrade the coating (Col.6, lines 54 – 68, and Col.7, lines 1 – 21). In other words, Loersch et al. teaches that the peening intensity is a result / effective variable that must be chosen / optimized to be high (i.e., to achieve a good surface finish in a short amount of time) but not too high (i.e., so that the coating or workpiece is not damaged). Therefore, it would have been obvious to one of ordinary skill in the art to optimize the peening intensity of the process of the combination of the AAPA and Nakamura et al. as a result / effective variable through routine experimentation in order to obtain a peening intensity that is high enough to achieve a good surface finish (i.e., high enough to provide the plastic deformation desired by Nakamura et al.) but not so high as to damage the aluminide bond coating or the workpiece itself.

Regarding independent **Claims 11 and 20**, the AAPA teaches a method of making a thermal barrier coating (TBC) system by depositing an aluminide bond coat, specifically a diffusion aluminide bond coat, that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the steps of depositing the diffusion aluminide bond coat on the component by VPA or CVD, the bond coat comprising an additive layer on the

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surface of the component and a diffusion zone in a surface region of the component, the additive layer being characterized by substantially columnar grains that extend from the diffusion zone to the surface of the bond coat, the grains having grain boundaries exposed at the surface of the aluminide bond coat, and then depositing a ceramic layer to form the TBC on the bond coat (See "PRIOR ART" Figures 2 – 5, page 8, lines 8 – 34, page 9, lines 1 – 35, and page 10, lines 1 – 24, of the applicant's specification, which depict and describe a TBC system of a type known in the art). The AAPA does not explicitly teach improving the thermal fatigue life of the TBC by modifying the grain structure of the (diffusion) aluminide bond coat by (1) peening the bond coat at an intensity of at least 6A (Claim 11), specifically at an intensity of 6A to 12A (Claim 20), (2) heat treating the bond coat before depositing the TBC on the surface of the bond coat so as to recrystallize at least a surface region of the bond coat, wherein new grains form within the additive layer at the surface of the bond coat (Claim 11), specifically heat treating at a temperature and for a duration sufficient to recrystallize the entire additive layer of the bond coat, wherein equiaxial grains form within the additive layer (Claim 20), and (3) producing new, equiaxed grains that have a grain size of about 15 to 30 micrometers (Claim 20). Nakamura et al. teaches that, after depositing a diffusion coating layer of Al (i.e., a diffusion aluminide bond coat) on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is shot-peened and then heated to a temperature at or above the recrystallization temperature of the coating layer, thereby causing recrystallized grains (i.e., "new grains") to form on the surface of the diffusion coating layer (i.e., in the additive layer of the diffusion aluminide bond coat) (Abstract). This recrystallization process advantageously allows the component / coating (1) to have an improved thermal fatigue

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resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract). Therefore, it would have been obvious to one of ordinary skill in the art to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component / blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance, (2) a lower crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system). The combination of the AAPA and Nakamura et al. does not explicitly teach the applicant's claimed peening intensity. However, it would have been obvious to one of ordinary skill in the art to optimize the peening intensity of the combination of the AAPA and Nakamura et al. through routine experimentation in light of the teachings of Loersch et al. (see paragraph 9 above). Regarding Claim 20, the combination of the AAPA, Nakamura et al., and Loersch et al. does not explicitly teach that the entire additive layer of the bond coat is recrystallized by the heat-treatment step. However, Nakamura et al. does teach that the outermost surface of the diffusion coating layer is recrystallized (Abstract). This "outermost surface of the diffusion coating layer" appears to correspond to the "additive layer" of the AAPA (i.e., as opposed to the diffusion zone portion of the diffusion coating, which is located within the component itself). It would have been obvious to one of ordinary skill in the art to heat-treat the diffusion bond coating of the AAPA for a temperature and time sufficient to recrystallize the

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entire additive layer of the bond coat with the reasonable expectation of successfully and advantageously maximizing the benefits of the recrystallization taught by Nakamura et al., such as providing the entire additive layer with a relatively small grain size, thereby most effectively retarding crack propagation. Further regarding Claim 20, the combination of the AAPA, Nakamura et al., and Loersch et al. does not explicitly teach that the new grains are equiaxial and have a grain size of from 15 to 30 micrometers. Specifically, the aforementioned combination is silent regarding the orientation and size of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation and size obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., and Loersch et al. would have inherently produced equiaxial grains having a size of from 15 to 30 micrometers, unless essential process steps and/or limitations are missing from the applicant's claims. Additionally, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches that the surface of the aluminide bond coat has surface irregularities as a result of grain boundary ridges defined by the grain boundaries at the surface of the aluminide bond coat (AAPA at Figure 2, page 9, lines 1 – 35, and page 10, lines 1 – 7), and following the recrystallizing step, the new, equiaxed grains cause the surface of the bond coat to be smoother

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and flatter as a result of eliminating at least some of the grain boundary ridges, whereby the ceramic layer is deposited on the smoother and flatter surface of the aluminide bond coat.

Specifically, the combination of the AAPA Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the flattened grain boundary ridges and smoother bond coat surface obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., and Loersch et al. would have inherently produced a bond coat having flattened grain boundary ridges and a smoother bond coat surface on which the ceramic layer / TBC is deposited, as required by Claims 11 and 20.

The combination of the AAPA, Nakamura et al., and Loersch et al. also teaches all the limitations of **Claims 13 – 18** as set forth above in paragraph 10 and below, including a method wherein / further comprising:

- Claim 13: The new grains have a grain size of not smaller than 5 micrometers after the TBC has been deposited. Specifically, although Nakamura et al. teaches that the new grains are “small” and “fine” (Abstract), Nakamura et al. is silent as to the specific size of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation

of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain size obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the aforementioned combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination references would have inherently produced new grains having a grain size of not smaller than 5 micrometers unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 14: The new grains are substantially equiaxed. Specifically, Nakamura et al. is silent regarding the orientation of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of references would have inherently produced substantially equiaxed

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grains unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 15: The aluminide bond coat is a single-phase or two-phase aluminide prior to recrystallization (page 9, lines 17 – 22, of the applicant's specification).
- Claim 16: Precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. Specifically, the combination of the AAPA, Nakamura et al., and Loersch et al. is silent regarding precipitates at the grain boundaries after recrystallization. However, the aforementioned combination of references teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the aforementioned combination of references would have inherently produced a bond coat having substantially no precipitates at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.
- Claim 17: The aluminide bond coat is single-phase aluminide after recrystallization. Specifically, the AAPA teaches that the bond coat, as deposited, is a single-phase or

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two-phase diffusion aluminide (page 9, lines 17 – 19, of the applicant's specification).

Additionally, the combination of the AAPA, Nakamura et al., and Loersch et al.

teaches each and every process step and limitation of the applicant's claims, including

the type of aluminide bond coat deposited, the step of peening the bond coat prior to

heat-treating the bond coat, and the step of recrystallizing the bond coat by heating

the bond coat at a temperature at or above the recrystallization temperature. Since the

single phase aluminide obtained in the applicant's claimed process is simply a

function of the recrystallization (i.e., peening / heating) process utilized by the

applicant (for support, see, for example, page 14, lines 18 – 20 of the applicant's

specification, which indicates that a bond coat recrystallization process yields a

single-phase), and the combination of the AAPA, Nakamura et al., and Loersch et al.

teaches the claimed recrystallization (i.e., peening / heating) process, the process of

the combination of the AAPA, Nakamura et al., and Loersch et al. would have

inherently produced a bond coat having a single-phase aluminide structure unless

essential process steps and/or limitations are missing from the applicant's claims

- Claim 18: The aluminide bond coat is a platinum aluminide bond coat (page 9, lines 11 – 19 of the applicant's specification).

Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), and in further view of Duhl et al. (USPN 4,512,817).

The combination of the AAPA and Nakamura et al. teaches all the limitations of **Claim 3** as set forth above in paragraph 6, except for a method wherein the aluminide bond coat is heated to a temperature of about 1090° C to about 1120° C during the recrystallizing step. Specifically, Nakamura et al. teaches heating the bond coat to a temperature at or above the recrystallization temperature of the coating (Abstract) and gives a specific example of heating to a temperature of 900° C (sections (9) and (10) of Nakamura et al., as verified by an oral translation from a USPTO translator). Duhl et al. teaches that the temperature of the post-deposition heat treatment of a bond coating is a result / effective variable that depends on various factors such as (1) the amount of coating interdiffusion desired, (2) the type of coating, (3) the substrate composition, and (4) the coating thickness (Col.3, lines 8 – 40). A high heat treatment temperature such as 2050° F (i.e., 1121° C – “about 1120° C”, as claimed by the applicant) can be utilized (Col.4, lines 7 – 16). It would have been obvious to one of ordinary skill in the art to utilize a high heat treatment temperature of, for example, about 1120° C (as taught by Duhl et al.), in the process of the combination of the AAPA and Nakamura et al. with the reasonable expectation of (1) success, as Nakamura et al. teaches heating the bond coat to a temperature at or above the recrystallization temperature of the coating (i.e., does not appear to place an upper limit on the heat treatment temperature) and (2) obtaining the benefit of using a higher heat treatment temperature than the 900° C temperature explicitly taught by Nakamura et al., such as performing the recrystallization more quickly, thereby increasing process throughput.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), in further view of Hayess et al. (USPN 6,210,744 B1).

The combination of the AAPA and Nakamura et al. teaches all the limitations of Claim 9 as set forth in paragraph 6 of the previous Office action, except for a method wherein recrystallization of at least the surface region of the aluminide bond coat occurs during deposition of the TBC on the surface of the bond coat. However, the AAPA does generally teach depositing a ceramic layer on the surface of the aluminide bond coat to form a thermal barrier coating (See "PRIOR ART" Figures 2 – 5, page 8, lines 8 – 34, page 9, lines 1 – 35, and page 10, lines 1 – 24, of the applicant's specification, which depict and describe a TBC system of a type known in the art), and Nakamura et al. reasonably suggests recrystallizing the diffusion aluminide coating by heating the coating to a temperature at or above the recrystallization temperature (Abstract) and gives a specific example of heating to a temperature of 900° C (see paragraph 13 of the previous Office action). Hayess et al. teaches that the temperature of a bond-coated component during the deposition of a ceramic TBC is preferably maintained between 900° C and 1150° C (i.e., a temperature above the recrystallization temperature of a diffusion aluminide bond coat – see Nakamura et al.) in order to provide good adhesion of the TBC to the bond coating and obtain a TBC having a desirable columnar microstructure (Col.3, lines 1 – 8 and 59 – 60, Col.4, line 65 – Col.5, line 12). Therefore, it would have been obvious to one of ordinary skill in the art to maintain the peened, bond-coated component of the combination of the AAPA and Nakamura et al. at a temperature between 900° C and 1150° C during the deposition of the TBC in order to reap the benefits associated with this deposition temperature (i.e., good

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adhesion of the TBC to the bond coating and a TBC having a desirable columnar microstructure). As this temperature is above the recrystallization temperature of the aluminide coating, it is the examiner's position that recrystallization of the peened bond coat would have inherently occurred to some extent during the deposition of the TBC. Alternatively, it would have been obvious to one of ordinary skill in the art to utilize the high temperature of the TBC deposition process to recrystallize the diffusion aluminide bond coating of the combination of the AAPA and Nakamura et al. with the reasonable expectation of (1) success, as such a temperature is above the recrystallization temperature of the coating, and (2) obtaining the benefits of recrystallizing the bond coat during TBC deposition, such as minimizing the total number of required process steps (e.g., because a separate heating / recrystallization step would not be necessary when the bond coat recrystallization occurs during TBC deposition) and maximizing throughput.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), in further view of Loersch et al. (USPN 4,514,469), and in further view of Duhl et al. (USPN 4,512,817).

The combination of the AAPA, Nakamura et al., and Loersch et al. teaches all the limitations of **Claim 12** as set forth above in paragraph 10, except for a method wherein the aluminide bond coat is heated to a temperature of about 1090° C to about 1120° C. However, this limitation would have been obvious to one of ordinary skill in the art in view of the teachings of Duhl et al. (see paragraph 13 above).

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), in further view of Loersch et al. (USPN 4,514,469), and in further view of Duderstadt et al. (USPN 5,238,752).

The combination of the AAPA, Nakamura et al., and Loersch et al. teaches all the limitations of **Claim 19** as set forth above in paragraph 10, except for a method wherein tantalum-rich precipitates are present in the grain boundaries of the grains after the depositing step and before recrystallization, and the tantalum-rich precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. However, the AAPA does teach that refractory phases "46" (i.e., precipitates) are present in the grain boundaries "34" of the grains after the depositing step and before recrystallization (Figure 2 and page 9, lines 20 – 35, of the applicant's specification). The refractory phases form during the bond coat deposition as a result of diffusion of refractory elements from the superalloy substrate (page 9, lines 32 – 35 of the applicant's specification). Additionally, the AAPA teaches that the substrate is a nickel or cobalt-based superalloy (page 8, lines 8 – 15, of the applicant's specification) but is silent regarding the specifics of the aforementioned superalloy. Duderstadt et al. teaches that typical nickel-based superalloy materials used to make turbine blades comprise tantalum (Col.4, lines 39 – 45, Col.8, lines 28 – 46, and Col.9, lines 35 – 43), and a certain amount of this tantalum diffuses into the bond coat from the substrate (Col.6, lines 14 – 22). It would have been obvious to one of ordinary skill in the art to utilize the specific, tantalum-containing nickel-based superalloy materials taught by Duderstadt et al. in making the nickel-based superalloy turbine blades of the AAPA, thereby performing a process in which tantalum-rich precipitates diffuse

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from the substrate and are present in the grain boundaries after depositing the bond coat (as taught by the AAPA and Duderstadt et al.), with the reasonable expectation of successfully and advantageously using a specific, well-known, nickel-based superalloy material (i.e., the material(s) taught by Duderstadt et al.) out of the broader genus of nickel-based superalloy materials generally taught by the AAPA in the turbine blade manufacturing process (i.e., using a known species out of a broader disclosed genus). Please note that the selection of a known material based on its suitability for its intended use supports a *prima facie* obviousness determination (See MPEP 2144.07). Additionally, the aforementioned combination of references is silent regarding tantalum-rich precipitates at the grain boundaries after recrystallization. However, the aforementioned combination of references teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the aforementioned combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., Loersch et al., and Duderstadt et al. would have inherently produced a bond coat having substantially no precipitates, including tantalum-rich precipitates, at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.

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(10) Response to Argument

AAPA and Nakamura

Appellant argues that neither the AAPA nor Nakamura teaches or suggests smoothing, flattening, and recrystallizing a diffusion aluminide bond coat on which a ceramic TBC is to be deposited and adhered (p.28 lines 1-4). This issue will be addressed below.

In addition, appellant's arguments can be generally classified into two issues:

- 1) that the applicant's admitted prior art (AAPA) teaches away from smoothing and flattening the surface of a diffusion aluminide bond coat (p.21 last paragraph of the Appeal Brief); and
- 2) that Nakamura does not teach a TBC layer on top of the diffusion bond coat (p.22 first paragraph of the Appeal Brief).

These issues will be addressed in separate headings.

Whether AAPA and Nakamura fail to teach claimed invention

Appellant generally argues that neither the AAPA nor Nakamura teaches or suggests smoothing, flattening, and recrystallizing a diffusion aluminide bond coat on which a ceramic TBC is to be deposited and adhered (p.28 lines 1-4).

The examiner disagrees. The AAPA teaches a diffusion aluminide bond coat on a superalloy component followed by a thermal barrier coating on the bond coat surface. The bond coat is characterized by substantially columnar grains and grain boundaries exposed at the bond coat surface. In addition, the AAPA fails to teach recrystallizing any portion of the bond coat

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prior to or during depositing a TBC. Appellant has not taken issue with this (p.20 of Appeal Brief).

Nakamura teaches corrosion-resistant coatings such as diffusion aluminide coatings for use in gas turbine engines in which after the deposition of the diffusion aluminide coating on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is subsequently shot-peened and then heated to a temperature at or above the recrystallization temperature of the coating layer, thereby causing fine recrystallized grains (i.e., “new grains”) to form on the surface of the diffusion coating layer. Appellant has not taken issue with this (p.22 of Appeal Brief).

As a result, it appears that the combination of AAPA and Nakamura, if properly and appropriately combined, meet the limitation of independent claim 1. Appellant has not argued this fact. To that end, the appellant argues that the combination of references cannot be properly combined because: 1) the AAPA teaches away from recrystallizing the diffusion aluminide bond coat and 2) Nakamura does not teach a TBC on the diffusion bond coat.

Issue 1: Whether the AAPA teaches away from the claimed invention:

Appellant argues that the AAPA teaches away from any processing (such as polishing or peening) that would result in smoothing and flattening the surface of a diffusion aluminide bond coat because the result would be reduced adhesion of the TBC and reduced crack resistance of the alumina scale-bond coat interface, thus promoting the spallation of the TBC (p.19 last paragraph, p.21 last paragraph, p.26 last 3 lines, p.28 lines 4-9, p.31 line 16 – p.32 line 4 of the

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Appeal Brief). The portions of the AAPA referred to by the appellant are the Background of the Invention; p.8 line 8 – p.10 line 24; and Figures 1 through 5 (p.20 lines 2-5 of the Appeal Brief).

The examiner disagrees. It is first noted that the AAPA teaches in general:

1) the differences between overlay bond coats and aluminide bond coats especially where the spallation occurs (p.2 line 4 – p.3 line 5),

2) the benefit of surface finish on overlay bond coats and the presumed disadvantage of polishing on diffusion aluminide bond coats (p.3 line 6 – p.4 line 15), and

3) the conventionality of the prior art to form a bond coat 24 overlying a superalloy substrate 22 followed by a thermal barrier coating layer 26 which results in a diffusion zone 30 and an alumina scale 36 (pp.8-10).

It is the examiner's position that the AAPA does not teach away from recrystallizing the bond coat. Indeed, the specification on p.3 lines 6-33 teaches an advantage of a smoother finish for the bond coat, albeit an overlay bond coat. One skilled in the art would reasonably expect that this advantage would be obtained for the diffusion aluminide bond coat.

With respect to appellant's assertion that there is reduced adhesion of the TBC, it is noted that there is no evidence of record to show that the TBC formed in the appellant's claimed method adheres as well as or better than that of the AAPA with the roughened surface.

In addition, there is no recitation anywhere in the appellant's specification that the recrystallization of the diffusion bond coat could not be performed; it just mentions that it would be expected to reduce TBC life and inhibit crack propagation (p.4 lines 1-15). Hence, it is the examiner's position that the appellant's specification does not preclude the recrystallization of the diffusion bond coat but presumes some disadvantages.

Assuming *arguendo* that the AAPA does teach away from the recrystallization of the diffusion bond coat, how does the appellant do the same and have it work? Independent claim 1 merely recites “recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the thermal barrier coating on the surface of the aluminide bond coat”, which is precisely what the appellant states that the AAPA teaches away from. Simply put, if the AAPA teaches away from recrystallizing the diffusion bond coat because of certain disadvantages, how does the appellant do it and succeed? It is the examiner’s position that there may be some process limitation not currently recited in the instant claims which produces this success.

Issue 2: Whether Nakamura can be combined if it does not teach a TBC

Appellant next argues that Nakamura does not teach a TBC layer on top of the diffusion bond coat (p.22 first paragraph and p.26 lines 7-9 of the Appeal Brief) and relies on the Spitsberg Declaration dated 2/22/06 to rebut the examiner’s motivation for combining the two references (p.28 line 10 – p.33 line 2 of the Appeal Brief).

The examiner disagrees. As mentioned above in *(9) Grounds of Rejection under AAPA in view of Nakamura for claims 1, 4-8, 10,* the AAPA does not explicitly teach improving the thermal fatigue life of the TBC by recrystallizing the aluminide bond coat during or prior to depositing the TBC and that Nakamura teaches a recrystallization process which advantageously allows the component / coating (1) to have an improved thermal fatigue resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract). Therefore, it is the examiner’s position that it would have been obvious

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to one of ordinary skill in the art to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component / blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance, (2) a lower crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system). It is the examiner's position that proper motivation has been provided.

With respect to the issue that Nakamura fails to teach a thermal barrier coating, the examiner concedes that Nakamura does not explicitly teach a thermal barrier coating. However, it is noted that Nakamura's plastic deformation step such as shot peening specifically forms fine recrystallized grains (p.7 lines 14-20 of the Translation of Nakamura) and that these fine crystals increase the yield strength of the coating layer, making it possible to obtain a coating layer with good resistance to thermal fatigue without a loss in resistance to corrosion (sentence bridging pp.7-8 of the Translation). The AAPA specifically teaches the service life of a TBC system is typically limited by spallation brought on by thermal fatigue (p.2 lines 30-32 of specification). It is the examiner's position that one skilled in the art after reading the spallation problems resulting from thermal fatigue of the AAPA would look to Nakamura's recrystallization step which provides good resistance to thermal fatigue to solve those problems.

In addition, the appellant relies on the Spitsberg Declaration to demonstrate the differences in failure mechanisms to show why the skilled artisan would not look to Nakamura to address the spallation problems of the TBC system of the AAPA (p.28 line 16 – p.30 line 4).

The examiner disagrees. It should first be noted that the Spitsberg Declaration filed 2/22/05 was addressed in detail in paragraphs 12-19 of the Final Rejection dated 5/26/05. With respect to the issue that the difference in failure mechanism would not lead one skilled in the art to look at Nakamura, the examiner disagrees with the appellant's conclusion. Assuming that the facts and opinions set forth in the declaration establishing a different failure mechanism was correct, one of ordinary skill in the art would still have been motivated to perform the peening/recrystallization process of Nakamura on the diffusion aluminide bond coat of the AAPA with the express purpose of obtaining high thermal fatigue resistance, good corrosion resistance, and reduced cracking/crack propagation. These bond coat properties would have been desired by one of ordinary skill in the turbine blade art, regardless of whether or not the bond coat is the ultimate cause of TBC failure/spallation. This is further supported by col.4 lines 39-63 of Nelson et al. (5,413,871) which discloses that cracks in a bond coat are a problem in the context of TBCs because even a small crack could serve as an entry point for undesirable contaminants passing through the TBC.

AAPA and Nakamura in view of Loersch, Duhl, Duderstadt, Hayess

Appellant argues that Loersch does nothing to alter the appellant's assertion that one skilled in the art would not overcome the teaching of the AAPA by peening, flattening, and recrystallizing a diffusion aluminide bond coat (pp.34-35 of the Appeal Brief).

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The examiner concurs. It is the examiner's position that Loersch was merely cited to show that peening intensity is a cause effective variable. Appellant has not challenged this position.

Appellant next argues that Duhl does nothing to alter the appellant's assertion that one skilled in the art would not overcome the teaching of the AAPA by peening, flattening, and recrystallizing a diffusion aluminide bond coat (pp.36-37 of the Appeal Brief).

The examiner concurs. It is the examiner's position that Duhl was merely cited to show that the temperature of the post-deposition heat treatment of a bond coating is a cause effective variable. Appellant has not challenged this position.

Appellant next argues that Duderstadt does nothing to alter the appellant's assertion that one skilled in the art would not overcome the teaching of the AAPA by peening, flattening, and recrystallizing a diffusion aluminide bond coat (pp.38-39 of the Appeal Brief).

The examiner concurs. It is the examiner's position that Duderstadt was merely cited to show that nickel-based superalloy materials used to make turbine blades typically comprise tantalum. Appellant has not challenged this position.

Appellant next argues that Hayess does nothing to alter the appellant's assertion that one skilled in the art would not overcome the teaching of the AAPA by peening, flattening, and recrystallizing a diffusion aluminide bond coat (pp.40-41 of the Appeal Brief).

The examiner concurs. It is the examiner's position that Hayess was merely cited to show that the temperature of a bond-coated component during the deposition of a ceramic TBC is preferably maintained between 900° C and 1150° C. Appellant has not challenged this position.

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Summary

The appellant has argued that one skilled in the art after reading the AAPA would not look to Nakamura to solve its deficiencies. It is the examiner's position that proper motivation to incorporate the recrystallization step of Nakamura into the process of the AAPA has been provided to obtain the advantages set forth in Nakamura including resistance to thermal fatigue, a recognized problem in the gas turbine art.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

B.Chen



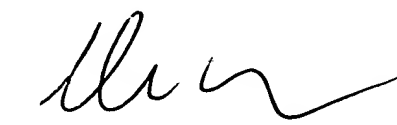
Conferees:

Timothy Meeks

Glenn Caldarola



TIMOTHY MEEKS
SUPERVISORY PATENT EXAMINER



Glenn Caldarola
Supervisory Patent Examiner
Technology Center 1700